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(54) TOUCH DETECTION IN A CAPACITIVE SENSOR SYSTEM

BERÜHRUNGSERKENNUNG IN EINEM KAPAZITIVEN SENSORSYSTEM

DÉTECTION TACTILE DANS UN SYSTÈME DE CAPTEUR CAPACITIF

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Description

[0001] The present disclosure relates to touch detection in a capacitive sensor system, in particular to touch detection for event based multiplexing of a mid-range capacitive sensor system with a touch controller.

[0002] To perform touch detection for an input device, various technologies are available, in particular capacitive and resistive systems are used to detect a touch on a surface such as a display or trackpad. Other systems have been developed that allow for the detection of three-dimensional, non-touching gestures performed in a defined area.

[0003] International Patent Application WO 2006/115946 discloses a touch sensitive device and method using pre-touch information. US 2012/0313882 discloses a system and method for contactless detection and recognition of gestures in a three-dimensional space. US 2012/050180 A1 discloses a touch and hover sensing system. US 2013/293489 A1 discloses a touch and proximity sensing system.

[0004] There is a need for an improved combination of touch and non-touch detection in electronic devices. This and other objects can be achieved by a system and method as defined in the independent claims. Further enhancements are characterized in the dependent claims.

Fig. 1A and 1B show block diagrams of combined 2D/3D touch/gesture detection systems;

Fig. 2 shows the 3D system in more detail;

Figs. 3-6, and 8 show various timing diagrams of received signals and their first derivative with respect to time;

Fig. 7 shows a block diagram of an Unscented Kalman filter;

Fig. 9 shows a block diagram of the low-latency touch detection algorithm.

[0005] According to various embodiments, a touch detection system and non-touch detection system are combined in electronic devices to form a complex input system. Touch controllers are generally used as stand-alone input devices and integrated, for example, in various electronic devices. However, according to various embodiments, three-dimensional (3D) sensing systems are combined with such touch sensing system or they are modified to provide for a touch detection function. A 3D gesture detection system is configured to work with a quasi-static alternating electric field, for example, using a 100-200 kHz square-wave signal fed to a transmitter electrode to build up such a field. Multiple detector electrodes are then used to determine attenuation caused by an object entering the field. An evaluation circuit, such as for example integrated circuit MGC3130 also known as GestIC® manufactured by Applicant, can be used to determine a 3D position. The MGC3130 is a single-zone 3D tracking and gesture controller device and described, for example, in the "Single-Zone 3D Tracking and Gesture Controller Data Sheet" available from Microchip Technology Inc.. Such a detection device applies trilateration with distance estimates derived from received signals from various electrodes to calculate the actual three-dimensional coordinates. However, other sensor systems may be combined with a touch sensing system as will be appreciated by a person skilled in the art. Furthermore, other 3D gesture detection systems may be used in combination with a touch sensing system according to various embodiments.

[0006] Touch detection systems are generally capacitive or resistive measurement systems that determine a change in capacitance or resistance caused by, for example, a finger touching a respective touch surface, such as, for example, a screen or track-pad.

[0007] 3D tracking and gesture detection devices or other sensor systems and touch controllers can be configured to collaborate for providing, for example, 3D gesture tracking and precise, high-resolution 2D touch information. However, both systems, the touch controller and the other sensor system, are generally not operated simultaneously for they would interfere with each other.

[0008] Therefore, according to various embodiments, a touch detection algorithm in the other sensor system, such as for example the GestIC® device, shall activate the touch controller on a touch event or an upcoming touch event detected by the respective other sensor system.

[0009] The activation has to take place with very low latency, so that the touch controller will not miss a quick touch. A noise source which harms the other sensor signal processing (incl. touch detection) is, for example, a 50/60 Hz power grid noise. Conventionally, it is combated by applying low-pass filtering, which, however, introduces some latency that has to be avoided.

[0010] According to one embodiment, the new algorithm, which for example can be applied to a GestIC® device, employs a stochastic filter for noise suppression instead of conventional low-pass filter to achieve low latency touch detection. Such a stochastic filter can be, for example, a stochastic filter that suppresses sinusoidal noise. In particular, such a stochastic filter can be an Unscented Kalman Filter.

[0011] Fig. 1A and 1B show input systems 100, 200 comprising a human machine interface that consists of a midrange Capacitive Sensor System (CSS) 110 for 3D gesture recognition and a touch controller (TC) 180 for precise, high-resolution 2D touch information. The 2D touch controller 180 can be, for example, a MTCH6301 projected capacitive touch (PCAP) controller manufactured by the Assignee of this application. A detailed description is available in the data sheet "MTCH6301" available from Microchip Technology Inc.. Other capacitive or resistive touch controllers may be used according to other embodiments.

[0012] In the shown embodiment of Fig. 1A, the CSS microcontroller 110 is connected to one transmit electrode (Tx) 170 and five receive electrodes (Rx0...4) 120, 130, 140, 150 and 160. The touch controller (TC) 180 drives/senses a touch panel 190. Alternatively, according to other embodiments, as shown for example in Fig. 1B, the CSS microcontroller 110 uses the touch panel 190 or one or more of its electrodes instead of a separate touch sensor electrode 160. A multiplexer switch 195 can then be used to switch between the CSS controller 110 and touch controller 180 as indicated by the connection lines coupling the multiplexer switch 195 with the touch panel electrode(s) 190 and either the touch controller 180 or the CSS microcontroller 110. In another embodiment, the touch panel 190 or one or more of its electrodes can be used as an additional transmit electrode of CSS while it is active.

[0013] Both devices 110 and 180 cannot operate simultaneously since their respective receive signals would be interfered by the transmit signal of the other device. However, simultaneous operation is not required because the user will either be performing 3D gestures above the touch panel or touching the touch panel 190.

[0014] While the user is not touching the touch panel, the CSS 110 is active, i.e. its transmit (TX) signal is turned on, and the TC 180 is off, i.e. its TX signal is turned off. As soon as the user is touching the touch panel 190, the TX signal of CSS 110 is switched off and that of TC 180 is activated. On release of the touch, the CSS 110 becomes active again and the TC 180 goes off. In order to realize this scheme, the CSS 110 needs a touch detection algorithm that, in the setup of Fig. 1, will run on the signal of electrode RX4, which covers the touch panel area. The four edge electrodes (Rx0...3) 120, 130, 140, 150 are used for gesture recognition.

[0015] Fig. 2 depicts the principle of CSS's signal acquisition. The Tx electrode 170 is driven by a rectangular pulse train of frequency f_{TX} (e.g. 100-200kHz). Depending on the user's interaction, the capacitance C_f between an Rx electrode 120, 130, 140, 150 and the user's finger changes. The voltage on C_f is measured by CSS's ADC 210, and its digital output signal is demodulated by demodulator 220 and down-sampled by down-sampler 230, 240 to obtain signal d at, e.g., 200Hz sample rate. This signal is input to Advanced Signal Processing (ASP) 250 which includes gesture recognition and touch detection.

[0016] The first step in ASP 250 is low-pass filtering in order to suppress noise from, for example, the 50/60Hz power grid, yielding signal LPd[k]. Fig. 3 shows the difference signal LPdiff[k] = LPd[k] - LPd[k-1] for a finger approach towards a sensor electrode without (left) and with a touch (right), respectively. In both cases the difference signal is greater than zero during the time of approach, and during the time of removal it is smaller than zero. The significant difference is that in case of a touch there is a characteristic bent in the signal near the crossing of the zero-line which is caused by the sudden deceleration of the finger upon its physical touch of the sensor electrode (or its cover). Therefore, in order to distinguish the signal resulting from a touch event from other movements like for example flick gestures, the signal is checked for this bent.

[0017] This is visualized in Fig. 4. The signal LPdiff is first checked for crossing of a positive threshold (1.) corresponding to a minimum speed of the finger in direction towards the sensor electrode. After LPdiff starts decreasing again (2.), a line is fitted onto LPdiff's negative slope, crossing the zero-line at time t_0. This time instance corresponds to zero-crossing of a signal that is observed for finger movement without touching. Hence, if LPdiff is still positive at t_0, the user's interaction is considered to be a touch (3.). The touch state is validated by comparing the offset-compensated LPd signal (signal deviation, SD) to a threshold (the closer the finger to the device, the larger the SD signal).

[0018] According to other embodiments, this touch detection algorithm can be used for a stand-alone CSS, too. Then, not only the touch event is evaluated, but additionally the touch state can be tracked on the SD value: the touch state is released as soon as the SD signal drops below a certain threshold again.

[0019] However, that additional low-pass filter in ASP 250 introduces some delay. With a typical delay of 50ms, a quick touch of 40ms would not be recognized by the TC 180 for the hand-over would take place too late. Consequently, a further touch detection has to work on signal d in order to feature low-latency hand-over to the TC 180.

[0020] Fig. 5 is a plot of an exemplary noisy signal d, which includes four touches. A touch cannot be identified by the absolute value as there is no reliable absolute reference. But a steep signal increase may serve as a feature.

[0021] Fig. 6 contains the difference signal of d (diff), i.e. diff[k] = d[k] - d[k-1]. The touch events do not appear very clearly due to the 50Hz noise, which might be even stronger in other environments and/or systems. In order to get rid of this sinusoidal noise, an Unscented Kalman Filter (UKF) is used to track and subtract it. The model the UKF is based on is presented in Fig. 7. The system state x comprises of amplitude, frequency and phase ([U; f; Φ]) of the power grid sinusoid. For complexity reason, states [U; f] or [U; Φ] may be chosen, too. The system state x is assumed to change at every time instance k according to $x_k = x_{k-1} + q_{k-1}$, where q denotes some process noise. From the system state, a measurement value y is calculated by $y_k = U_k \sin(2\pi f_k + \Phi_k) + r_k$, where r denotes some measurement noise.

[0022] The concept of Kalman filtering is to calculate a predicted system state x' (and measurement value y') from a known measurement value y with lowest error. Core of Kalman filtering is the Kalman gain K which is needed to correct the predicted state depending on the true measurement y: $x_k = x' - K\,(y_k - y')$. K depends on statistical properties of x', y', q and r.

[0023] The original Kalman filter is derived for linear systems, for non-linear systems several derivatives are known such as the Extended Kalman Filter, the Particle Filter, and the Unscented Kalman Filter.

[0024] The key point of Unscented Kalman filtering is to derive the above mentioned statistical properties of x' and y' by means of so-called sigma points. This implies complex computations including a matrix square root, but avoids linearization of the sine function and results in precise estimation of the sinusoid.

[0025] Having estimated the parameters of the power grid sinusoid, it can be subtracted from the diff signal shown in Fig. 6, thus yielding a cleaned diff signal, which is plotted in Fig. 8. Now, the touch events are unveiled from the noise. They can be detected easily and without false alarms by comparing the cleaned diff signal to a threshold 800, which has a value of 10 in this example.

[0026] Fig. 9 summarizes the low-latency touch detection algorithm. Starting with signal d, its difference signal is calculated by storage element 910 and summing point 920 and fed into the Unscented Kalman Filter 930. The filter 930 estimates the 50/60Hz component in the differential signal. The estimated sinusoid is then subtracted from the diff signal at summing point 940. Finally, the so cleaned diff signal is input to a threshold comparison 950, which outputs touch events. On these touch events, the CSS 110 is switched off and the TC 180 becomes active.

[0027] In summary, according to various embodiments, the concept of an external sensor activating the touch controller is provided. Furthermore, a touch detection algorithms for a midrange capacitive sensor system is provided which allows for a) exploiting the characteristic signal shape when the finger stops on the sensor's surface and b) suppressing sinusoidal noise by prediction, e.g. a UKF, thus avoiding delays of conventional filters.

Claims

1. A system comprising:

a capacitive or resistive two-dimensional, 2D, touch detection system (180, 190) comprising a touch sensor panel (190), operable to be activated and de-activated;

an additional three-dimensional, 3D, capacitive sensor system (110, 120, 130, 140, 150, 160, 170) configured to detect 3D gestures and comprising a transmission electrode (170) and a plurality of receive electrodes (120, 130, 140, 150, 160), wherein the transmission electrode (170) is configured to receive an alternating signal to generate a quasi-static alternating electric field and wherein at least some of the plurality of receive electrodes (120, 130, 140, 150) are used to determine attenuation of the electric field caused by an object entering the electric field to determine a 3D position, wherein the additional 3D capacitive sensor system (110, 120, 130, 140, 150, 160, 170) is in communication with the capacitive or resistive 2D touch detection system (180, 190);

wherein the capacitive or resistive 2D touch detection system (180, 190) and the additional 3D capacitive sensor system (110, 120, 130, 140, 150, 160, 170) are not operated simultaneously due to interference;

wherein the additional 3D capacitive sensor system (110, 120, 130, 140, 150, 160, 170) is configured to determine whether a touch event has occurred or is about to occur, and to activate the capacitive or resistive 2D touch detection system (180, 190) if a touch event has occurred or is about to occur,

wherein the 3D capacitive sensor system (110, 120, 130, 140, 150, 160, 170) is configured to run a touch detection algorithm on a signal from a touch detection electrode (RX4, 160, 190), which covers an area used by the capacitive or resistive 2D touch detection system (180, 190), wherein a difference signal of subsequent samples from the touch detection electrode (160; 190) is generated and evaluated over time, and wherein the 3D capacitive sensor system (110, 120, 130, 140, 150, 160, 170) is configured to determine whether a touch occurred by evaluating whether the difference signal first crosses a positive threshold and when the difference signal starts decreasing again, fitting a line onto a negative slope of the difference signal to determine a time t_0 of a potential zero crossing of the difference signal and determining whether the difference signal is still positive at the time t_0 to determine that a touch occurred.

2. A method for operating an input device, comprising:

providing a capacitive or resistive two-dimensional, 2D, touch detection system (180, 190) comprising a touch sensor panel (190), operable to be activated and de-activated;

providing an additional three-dimensional, 3D, capacitive sensor system (110, 120, 130, 140, 150, 160, 170) configured to detect 3D gestures and comprising a transmission electrode (170) and a plurality of receive electrodes (120, 130, 140, 150, 160), wherein the transmission electrode (170) is configured to receive an alternating signal to generate a quasi-static alternating electric field and wherein at least some of the plurality of receive electrodes (120, 130, 140, 150) are used to determine attenuation of the electric field caused by an object entering the electric field to determine a 3D position, wherein the additional 3D capacitive sensor system (110, 120, 130, 140, 150, 160, 170) is in communication with the capacitive or resistive 2D touch detection system (180, 190), wherein the additional capacitive sensor system (110, 120, 130, 140, 150, 160, 170) is capable to determine whether a touch event has occurred; wherein the capacitive or resistive 2D touch detection system (180, 190) and the additional 3D capacitive sensor system (110, 120, 130, 140, 150, 160, 170) are not operated simultaneously due to interference;

activating the additional capacitive sensor system (110-170) and deactivating the 2D touch detection system (180, 190);

determining by the additional capacitive sensor system (110-170) whether a touch event has occurred or is about to occur;

activating the capacitive or resistive 2D touch detection system (180, 190) if a touch event has occurred or is about to occur, running a touch detection algorithm by the 3D capacitive sensor system (110, 120, 130, 140, 150, 160, 170) on a signal from touch detection electrode (RX4, 160), which covers an area used by the capacitive or resistive 2D touch detection system (180, 190), wherein a difference signal of subsequent samples from the touch detection electrode (160; 190) is generated and evaluated over time, and determining by the 3D capacitive sensor system (110, 120, 130, 140, 150, 160, 170) whether a touch occurred by evaluating whether the difference signal first crosses a positive threshold and when the difference signal starts decreasing again, fitting a line onto a negative slope of the difference signal to determine a time t_0 of a potential zero crossing of the difference signal and determining whether the difference signal is still positive at the time t_0 to determine that a touch occurred.

3. The system or method according to claim 1 or 2, wherein the capacitive 2D touch detection system comprises a projected capacitive touch controller (180).

4. The system or method according to one of the preceding claims,
wherein for determination of a touch event, the 3D gesture detection system (110, 120, 130, 140, 150, 160, 170) comprises a stochastic filter (930) for noise suppression.

5. The system or method according to claim 4, wherein the stochastic filter (930) is an Unscented Kalman filter.

6. The system or method according to claim 4 or 5, wherein the stochastic filter (930) is configured to suppress sinusoidal noise.

7. The system or method according to claim 4 or 5, wherein the touch detection electrode is one of the plurality of receive electrodes (RX4, 160).

8. The system according to claim 1 or method according to claim 2, wherein the at least some of the receive electrodes (120, 130, 140, 150) are arranged as edge electrodes and configured to determine a gesture.

9. The system or method according to claim 8, further comprising a multiplexer switch (195) configured to share the touch panel (190) between the 3D gesture detection system (110, 120, 130, 140, 150, 160, 170) and the capacitive or resistive 2D touch detection system (180, 190).

10. The system according to claim 1 or method according to claim 2, wherein the at least some of the receive electrodes (120, 130, 140, 150) are arranged as edge electrodes and configured to determine a gesture, wherein a multiplexer (195) configured to share at least one electrode (190) from the touch detection system (180, 190) to operate as the transmission electrode for the 3D gesture detection system (110-170).

11. The method according to claim 2, wherein the difference signal is fed to an Unscented Kalman Filter (930).

12. The method according to claim 11, wherein an output signal of the Unscented Kalman Filter (930) is subtracted from the difference signal and fed to a threshold comparison unit (950) which is configured to output a touch event signal.

Patentansprüche

1. System, das aufweist:

ein kapazitives oder resistives zweidimensionales, 2D-, Berührungserkennungssystem (180, 190), das ein Berührungssensorfeld (190) aufweist, das aktiviert und deaktiviert werden kann; ein zusätzliches kapazitives dreidimensionales, 3D-, Sensorsystem (110, 120, 130, 140, 150, 160, 170), das so ausgebildet ist, dass es 3D-Gesten erkennt, und das eine Übertragungselektrode (170) und eine Vielzahl von Empfangselektroden (120, 130, 140, 150, 160) aufweist, wobei die Übertragungselektrode (170) so ausgebildet ist, dass sie ein Wechselsignal empfängt, um ein quasistatisches elektrisches Wechselfeld zu erzeugen, und wobei zumindest einige der Vielzahl von Empfangselektroden (120, 130, 140, 150) verwendet werden, um die Abschwächung des elektrischen Feldes zu bestimmen, die durch ein Objekt verursacht wird, das in das elektrische Feld eintritt, um eine 3D-Position zu bestimmen, wobei das zusätzliche

kapazitive 3D-Sensorsystem (110, 120, 130, 140, 150, 160, 170) mit dem kapazitiven oder resistiven 2D-Berührungserkennungssystem (180, 190) in Verbindung steht;
wobei das kapazitive oder resistive 2D-Berührungserkennungssystem (180, 190) und das zusätzliche kapazitive 3D-Sensorsystem (110, 120, 130, 140, 150, 160, 170) aufgrund von Interferenzen nicht gleichzeitig betrieben werden;
wobei das zusätzliche kapazitive 3D-Sensorsystem (110, 120, 130, 140, 150, 160, 170) so ausgebildet ist, dass es bestimmt, ob ein Berührungsereignis aufgetreten ist oder in Kürze auftreten wird, und dass es das kapazitive oder resistive 2D-Berührungserkennungssystem (180, 190) aktiviert, wenn ein Berührungsereignis aufgetreten ist oder in Kürze auftreten wird, wobei das kapazitive 3D-Sensorsystem (110, 120, 130, 140, 150, 160, 170) ausgebildet ist, um einen Berührungserkennungsalgorithmus auf ein Signal von einer Berührungserkennungselektrode (RX4, 160, 190) auszuführen, die einen Arbeitsbereich abdeckt, der von dem kapazitiven oder resistiven 2D-Berührungserkennungssystem (180, 190) verwendet wird, wobei ein Differenzsignal von aufeinanderfolgenden Abtastungen von der Berührungserkennungselektrode (160; 190) erzeugt und über die Zeit ausgewertet wird, und wobei das kapazitive 3D-Sensorsystem (110, 120, 130, 140, 150, 160, 170) ausgebildet ist, um zu bestimmen, ob eine Berührung stattgefunden hat, indem ausgewertet wird, ob das Differenzsignal zuerst einen positiven Schwellenwert kreuzt, und wenn das Differenzsignal wieder zu sinken beginnt, eine Linie an eine negative Steigung des Differenzsignals angepasst wird, um einen Zeitpunkt t_0 eines möglichen Nulldurchgangs des Differenzsignals zu bestimmen, und bestimmt wird, ob das Differenzsignal zu dem Zeitpunkt t_0 noch positiv ist, um zu bestimmen, dass eine Berührung stattgefunden hat.

2. Verfahren zum Betreiben einer Eingabevorrichtung, das aufweist:

Bereitstellen eines kapazitiven oder resistiven zweidimensionalen, 2D-, Berührungserkennungssystems (180, 190), das ein Berührungssensorfeld (190) aufweist, das aktiviert und deaktiviert werden kann;
Bereitstellen eines zusätzlichen kapazitiven dreidimensionalen, 3D-, Sensorsystems (110, 120, 130, 140, 150, 160, 170), das so ausgebildet ist, dass es 3D-Gesten erkennt, und das eine Übertragungselektrode (170) und eine Vielzahl von Empfangselektroden (120, 130, 140, 150, 160) aufweist, wobei die Übertragungselektrode (170) so ausgebildet ist, dass sie ein Wechselsignal empfängt, um ein quasistatisches elektrisches Wechselfeld zu erzeugen, und wobei zumindest einige der Vielzahl von Empfangselektroden (120, 130, 140, 150) verwendet werden, um eine Abschwächung des elektrischen Feldes zu bestimmen, die durch ein Objekt verursacht wird, das in das elektrische Feld eintritt, um eine 3D-Position zu bestimmen, wobei das zusätzliche kapazitive 3D-Sensorsystem (110, 120, 130, 140, 150, 160, 170) mit dem kapazitiven oder resistiven 2D-Berührungserkennungssystem (180, 190) in Verbindung steht, wobei das zusätzliche kapazitive Sensorsystem (110, 120, 130, 140, 150, 160, 170) in der Lage ist, zu bestimmen, ob ein Berührungsereignis stattgefunden hat;
wobei das kapazitive oder resistive 2D-Berührungserkennungssystem (180, 190) und das zusätzliche kapazitive 3D-Sensorsystem (110, 120, 130, 140, 150, 160, 170) aufgrund von Interferenzen nicht gleichzeitig betrieben werden;
Aktivieren des zusätzlichen kapazitiven Sensorsystems (110-170) und Deaktivieren des 2D-Berührungserkennungssystems (180, 190);
Bestimmen durch das zusätzliche kapazitive Sensorsystem (110-170), ob ein Berührungsereignis aufgetreten ist oder in Kürze auftreten wird;
Aktivieren des kapazitiven oder resistiven 2D-Berührungserkennungssystems (180, 190), wenn ein Berührungsereignis aufgetreten ist oder bevorsteht, Ausführen eines Berührungserkennungsalgorithmus durch das kapazitive 3D-Sensorsystem (110, 120, 130, 140, 150, 160, 170) auf ein Signal von der Berührungserkennungselektrode (RX4, 160), die einen vom kapazitiven oder resistiven 2D-Berührungserkennungssystem (180, 190) genutzten Arbeitsbereich abdeckt, wobei ein Differenzsignal von aufeinanderfolgenden Abtastungen von der Berührungserkennungselektrode (160; 190) erzeugt und über die Zeit ausgewertet wird, und Bestimmen durch das kapazitive 3D-Sensorsystem (110, 120, 130, 140, 150, 160, 170), ob eine Berührung stattgefunden hat, indem ausgewertet wird, ob das Differenzsignal zuerst einen positiven Schwellenwert kreuzt und wenn das Differenzsignal wieder zu sinken beginnt, eine Linie an eine negative Steigung des Differenzsignals angepasst wird, um einen Zeitpunkt t_0 eines möglichen Nulldurchgangs des Differenzsignals zu bestimmen, und bestimmt wird, ob das Differenzsignal zum Zeitpunkt t_0 noch positiv ist, um zu bestimmen, dass eine Berührung stattgefunden hat.

3. System oder Verfahren gemäß Anspruch 1 oder 2, wobei das kapazitive 2D-Berührungserkennungssystem eine prognostizierte kapazitive Berührungssteuerung (180) aufweist.

4. System oder Verfahren gemäß einem der vorhergehenden Ansprüche, wobei das 3D-Gestenerkennungssystem (110, 120, 130, 140, 150, 160, 170) zur Bestimmung eines Berührungsereignisses einen stochastischen Filter (930) zur Rauschunterdrückung aufweist.

5. System oder Verfahren gemäß Anspruch 4, wobei der stochastische Filter (930) ein Unscented-Kalman-Filter ist.

6. System oder Verfahren gemäß Anspruch 4 oder 5, wobei der stochastische Filter (930) so ausgebildet ist, dass er sinusförmiges Rauschen unterdrückt.

7. System oder Verfahren gemäß Anspruch 4 oder 5, wobei die Berührungserkennungselektrode eine der Vielzahl von Empfangselektroden (RX4, 160) ist.

8. System gemäß Anspruch 1 oder Verfahren gemäß Anspruch 2, wobei die zumindest einigen der Empfangselektroden (120, 130, 140, 150) als Randelektroden angeordnet und zur Bestimmung einer Geste ausgebildet sind.

9. System oder Verfahren gemäß Anspruch 8, das weiterhin einen Multiplexer-Schalter (195) aufweist, der so ausgebildet ist, dass er das Berührungsfeld (190) zwischen dem 3D-Gestenerkennungssystem (110, 120, 130, 140, 150, 160, 170) und dem kapazitiven oder resistiven 2D-Berührungserkennungssystem (180, 190) teilt.

10. System gemäß Anspruch 1 oder Verfahren gemäß Anspruch 2, wobei zumindest einige der Empfangselektroden (120, 130, 140, 150) als Randelektroden angeordnet und so ausgebildet sind, dass sie eine Geste bestimmen, wobei ein Multiplexer (195) so ausgebildet ist, dass er zumindest eine Elektrode des Berührungserkennungssystems (180, 190) gemeinsam nutzt, um als die Übertragungselektrode für das 3D-Gestenerkennungssystem (110-170) zu arbeiten.

11. Verfahren gemäß Anspruch 2, wobei das Differenzsignal in einen Unscented-Kalman Filter (930) eingespeist wird.

12. Verfahren gemäß Anspruch 11, wobei ein Ausgangssignal des Unscented-Kalman-Filters (930) von dem Differenzsignal subtrahiert und in eine Schwellenwert-Vergleichseinheit (950) eingespeist wird, die so ausgebildet ist, dass sie ein Berührungsereignissignal ausgibt.

Revendications

1. Système comprenant :

un système de détection tactile capacitif ou résistif bidimensionnel, 2D (180, 190) comprenant un panneau capteur tactile (190), pouvant être actionné de façon à être activé et désactivé ;
un système de capteur capacitif tridimensionnel, 3D, supplémentaire (110, 120, 130, 140, 150, 160, 170) configuré pour détecter des gestes 3D et comprenant une électrode d'émission (170) et une pluralité d'électrodes de réception (120, 130, 140, 150, 160),
dans lequel l'électrode d'émission (170) est configurée pour recevoir un signal alternatif de manière à générer un champ électrique alternatif quasi-statique, et dans lequel certaines au moins de la pluralité d'électrodes de réception (120, 130, 140, 150) sont utilisées pour déterminer une atténuation du champ électrique provoquée par un objet qui pénètre dans le champ électrique, pour déterminer une position 3D, dans lequel le système de capteur capacitif 3D supplémentaire (110, 120, 130, 140, 150, 160, 170) est en communication avec le système de détection tactile 2D capacitif ou résistif (180, 190) ;
dans lequel le système de détection tactile 2D capacitif ou résistif (180, 190), et le système de capteur capacitif 3D supplémentaire (110, 120, 130, 140, 150, 160, 170), ne sont pas actionnés simultanément en raison d'interférences ;
dans lequel le système de capteur capacitif 3D supplémentaire (110, 120, 130, 140, 150, 160, 170) est configuré pour déterminer si un événement tactile s'est produit, ou est sur le point de se produire, et d'activer le système de détection tactile 2D capacitif ou résistif (180, 190) si un événement tactile s'est produit, ou est sur le point de se produire,
dans lequel le système de capteur capacitif 3D (110, 120, 130, 140, 150, 160, 170) est configuré pour exécuter un algorithme de détection tactile sur un signal provenant d'une électrode de détection tactile (RX4, 160, 190), qui couvre une zone utilisée par le système de détection tactile 2D capacitif ou résistif (180, 190), dans lequel un signal différence d'échantillons suivants provenant de l'électrode de détection tactile (160 ; 190) est généré et évalué dans le temps, et dans lequel le système de capteur capacitif 3D (110, 120 , 130, 140, 150, 160, 170) est configuré pour déterminer si un contact tactile s'est produit en évaluant si le signal différence franchit d'abord un seuil positif, et lorsque le signal différence recommence à diminuer, régler une ligne sur une pente négative du signal différence pour dé-

terminer l'instant d'un passage par le potentiel zéro du signal différence, et déterminer si le signal différence est toujours positif à l'instant pour déterminer qu'un contact tactile s'est produit.

2. Procédé destiné à actionner un dispositif d'entrée, comprenant les étapes suivantes :

fournir un système de détection tactile capacitif ou résistif bidimensionnel, 2D (180, 190) comprenant un panneau capteur tactile (190), pouvant être actionné de façon à être activé et désactivé ;
fournir un système de capteur capacitif tridimensionnel, 3D, supplémentaire (110, 120, 130, 140, 150, 160, 170) configuré pour détecter des gestes 3D, et comprenant une électrode d'émission (170), et une pluralité d'électrodes de réception (120, 130, 140, 150, 160),
dans lequel l'électrode d'émission (170) est configurée pour recevoir un signal alternatif de manière à générer un champ électrique alternatif quasi-statique, et dans lequel certaines au moins de la pluralité d'électrodes de réception (120, 130, 140, 150) sont utilisées pour déterminer une atténuation du champ électrique provoquée par un objet qui pénètre dans le champ électrique, pour déterminer une position 3D, dans lequel le système de capteur capacitif 3D supplémentaire (110, 120, 130, 140, 150, 160, 170) est en communication avec le système de détection tactile 2D capacitif ou résistif (180, 190), dans lequel le système de capteur capacitif supplémentaire (110, 120, 130, 140, 150, 160, 170) est capable de déterminer si un événement tactile s'est produit ; dans lequel le système de détection tactile 2D capacitif ou résistif (180, 190), et le système de capteur capacitif 3D supplémentaire (110, 120, 130, 140, 150, 160, 170), ne sont pas actionnés simultanément en raison d'interférences ;
activer le système de capteur capacitif supplémentaire (110 - 170) et désactiver le système de détection tactile 2D (180, 190) ;
déterminer, avec le système de capteur capacitif supplémentaire (110 - 170) si un événement tactile s'est produit, ou est sur le point de se produire ;
activer le système de détection tactile 2D capacitif ou résistif (180, 190), si un événement tactile s'est produit, ou est sur le point de se produire, exécuter un algorithme de détection tactile avec le système de capteur capacitif 3D (110, 120, 130, 140, 150, 160, 170) sur un signal provenant d'une électrode de détection tactile (RX4, 160), qui couvre une zone utilisée par le capteur 2D capacitif ou résistif système de détection tactile (180, 190), dans lequel un signal différence d'échantillons suivants provenant de l'électrode de détection tactile (160 ; 190), est généré et évalué dans le temps, et déterminer, avec le système de capteur capacitif 3D (110, 120, 130, 140, 150, 160, 170), si un contact s'est produit en évaluant si le signal différence franchit d'abord un seuil positif, et lorsque le signal différence recommence à diminuer, régler une ligne sur une pente négative du signal différence pour déterminer l'instant du passage par le potentiel zéro du signal différence, et déterminer si le signal différence est toujours positif à l'instant où l'on détermine qu'un contact tactile s'est produit.

3. Système ou procédé selon la revendication 1 ou 2, dans lequel le système de détection tactile capacitif 2D comprend un contrôleur de contact tactile capacitif projeté (180).

4. Système ou procédé selon l'une quelconque des revendications précédentes, dans lequel, pour déterminer un événement tactile, le système de détection de geste 3D (110, 120, 130, 140, 150, 160, 170) comprend un filtre stochastique (930) à des fins de suppression du bruit.

5. Système ou procédé selon la revendication 4, dans lequel le filtre stochastique (930) est un filtre de Kalman dit « Unscented ».

6. Système ou procédé selon la revendication 4 ou 5, dans lequel le filtre stochastique (930) est configuré pour supprimer un bruit sinusoïdal.

7. Système ou procédé selon la revendication 4 ou 5, dans lequel l'électrode de détection tactile est l'une de la pluralité d'électrodes de réception (RX4, 160).

8. Système selon la revendication 1, ou procédé selon la revendication 2, dans lequel les certaines au moins des électrodes de réception (120, 130, 140, 150) sont agencées en tant qu'électrodes de bord, et sont configurées pour déterminer un geste.

9. Système ou procédé selon la revendication 8, comprenant en outre un commutateur multiplexeur (195) configuré pour partager l'écran tactile (190) entre le système de détection de geste 3D (110, 120, 130, 140, 150, 160, 170), et le système de détection tactile 2D capacitif ou résistif (180, 190).

10. Système selon la revendication 1, ou procédé selon la revendication 2, dans lequel les certaines au moins des électrodes de réception (120, 130, 140, 150) sont agencées en tant qu'électrodes de bord, et sont configurées pour déterminer un geste, dans lequel un multiplexeur (195) est configuré pour partager une électrode (190) au moins du système de détection tactile (180, 190), pour fonctionner en tant qu'électrode d'émission du système de détection de geste 3D (110 - 170).

11. Procédé selon la revendication 2, dans lequel le signal différence est transmis à un filtre de Kalman dit « Unscented » (930).

12. Procédé selon la revendication 11, dans lequel un signal de sortie du filtre de Kalman dit « Unscented » (930) est soustrait du signal différence, et transmis à une unité de comparaison de seuil (950) qui est configurée pour délivrer en sortie un signal d'événement tactile.

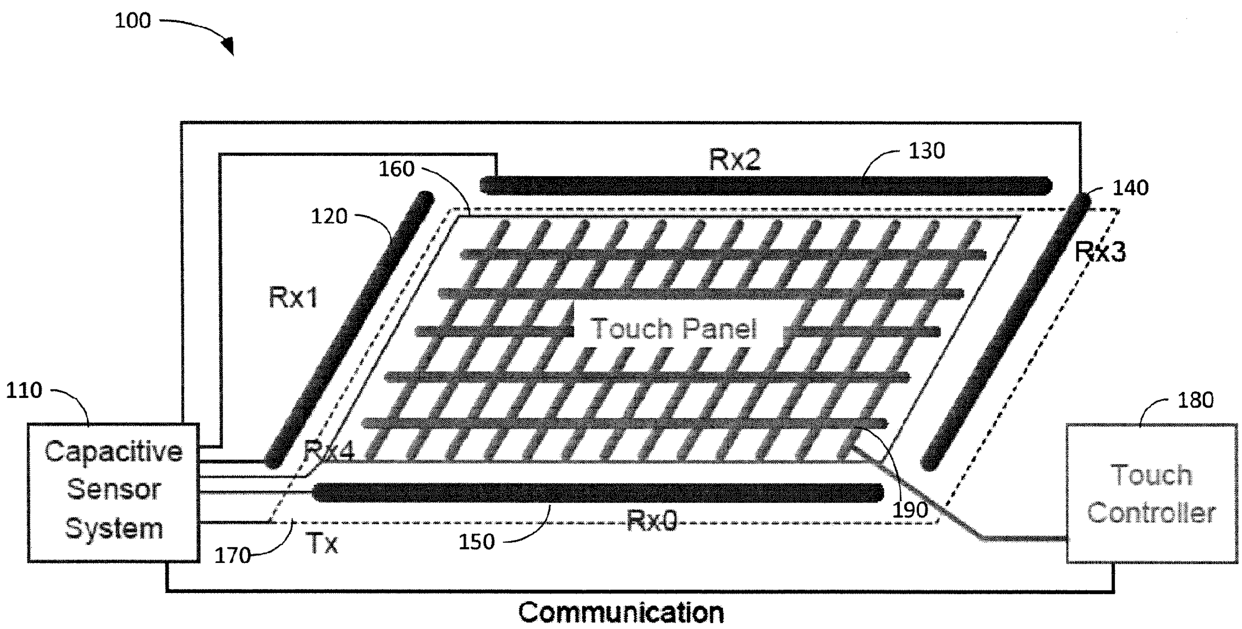

100
Rx2
130
160
140
120
Rx3
Rx1
Touch Panel
110
180
Capacitive Sensor System
Rx4
Touch Controller
190
Rx0
170
Tx
150
Communication

Figure 1A

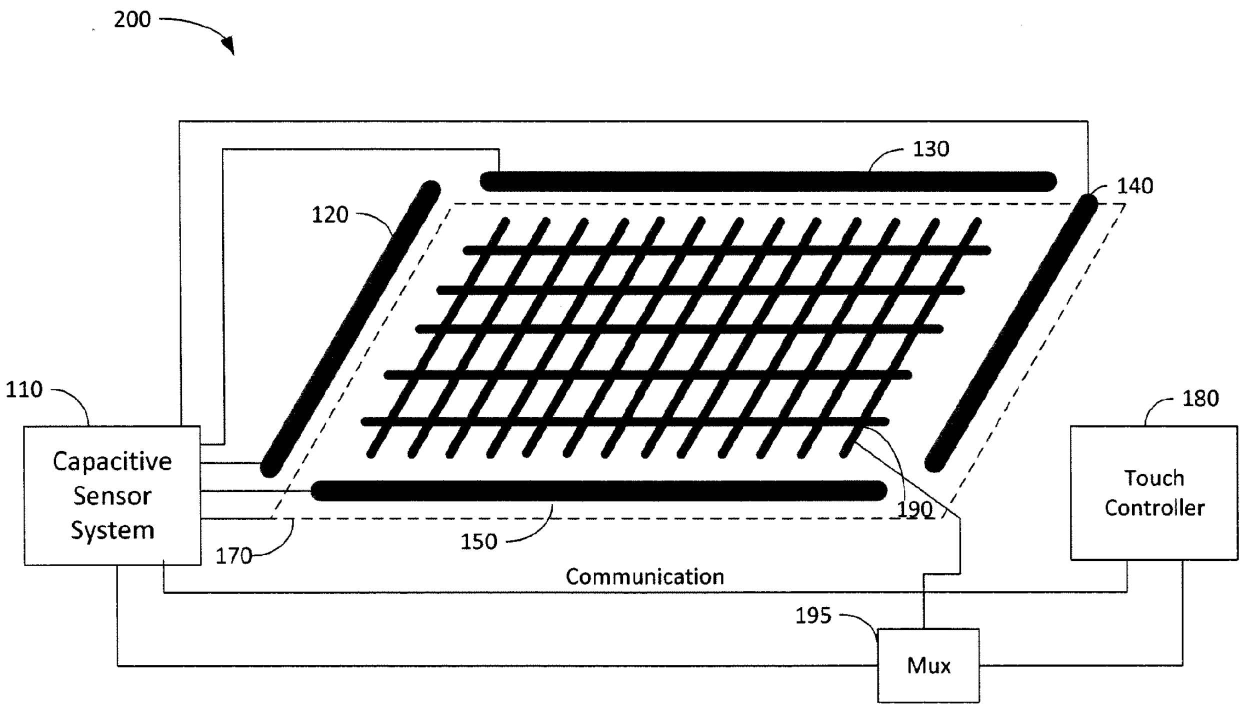
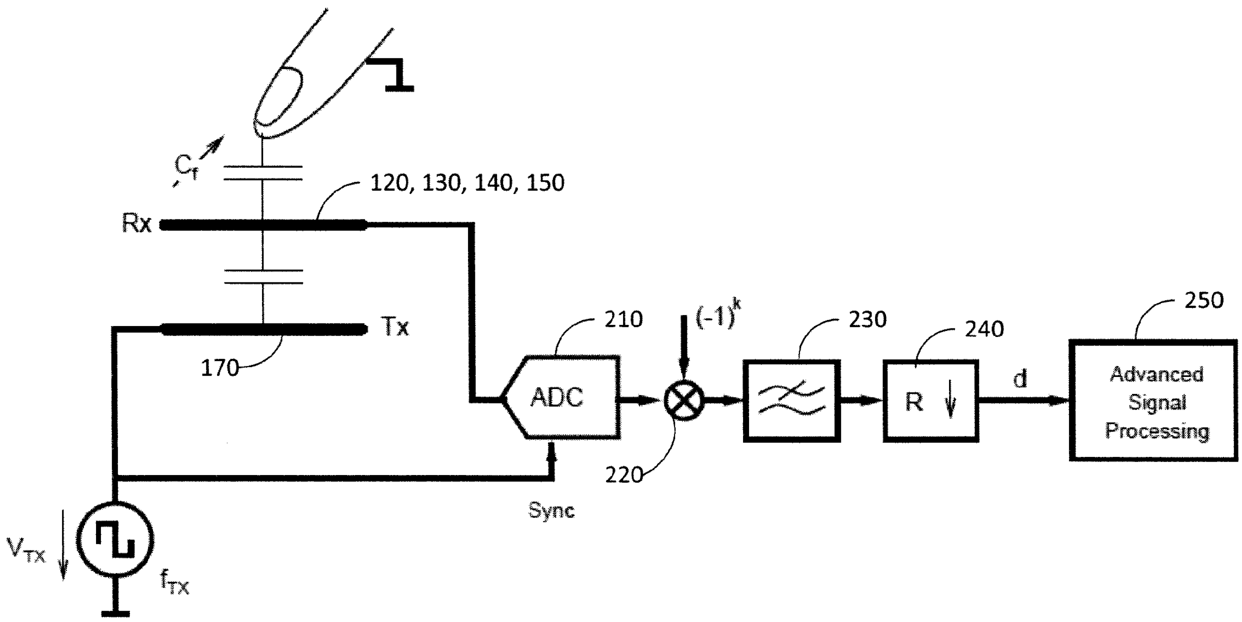

200
130
140
120
110
180
Capacitive
Sensor
System
Touch
Controller
190
170
150
Communication
195
Mux

Figure 1B



C_f
120, 130, 140, 150
Rx
Tx
170
210
ADC
$(-1)^k$
230
240
250
d
R
Advanced Signal Processing
220
Sync
V_{TX}
f_{TX}

Figure 2

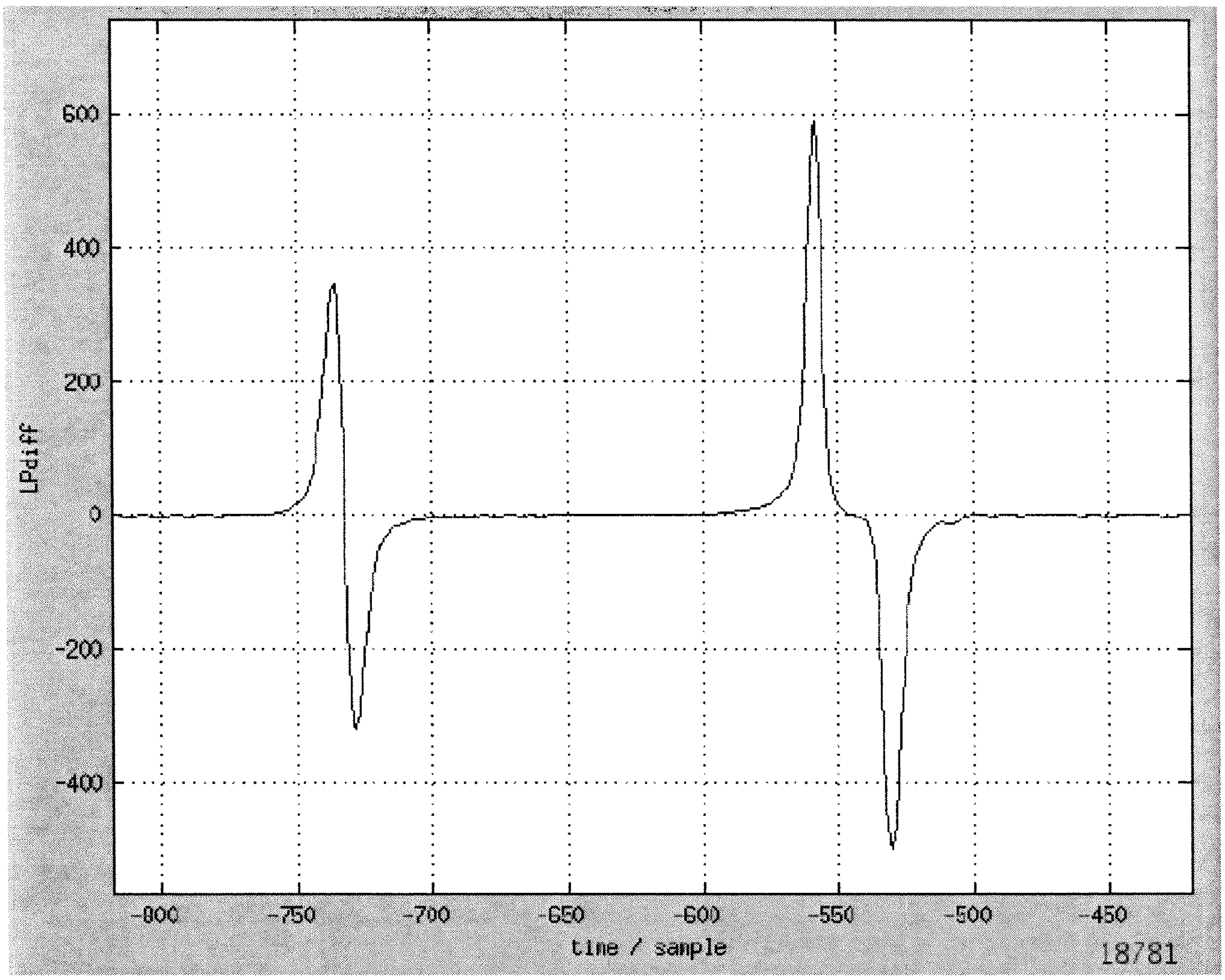

600
400
200
0
-200
-400
LPdiff
-800
-750
-700
-650
-600
-550
-500
-450
time / sample
18781

Figure 3

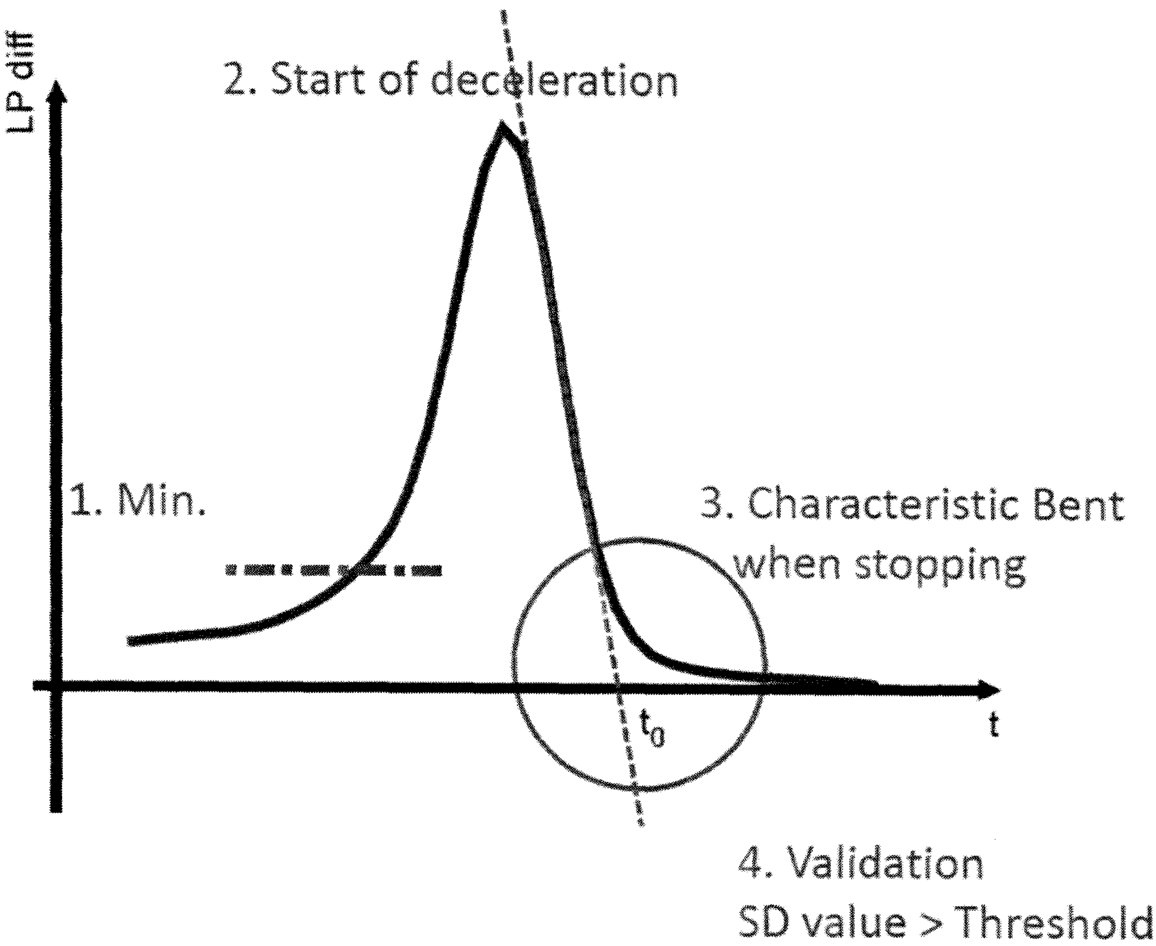

LP diff
2. Start of deceleration
1. Min.
3. Characteristic Bent
when stopping
t_0
t
4. Validation
SD value > Threshold

Figure 4

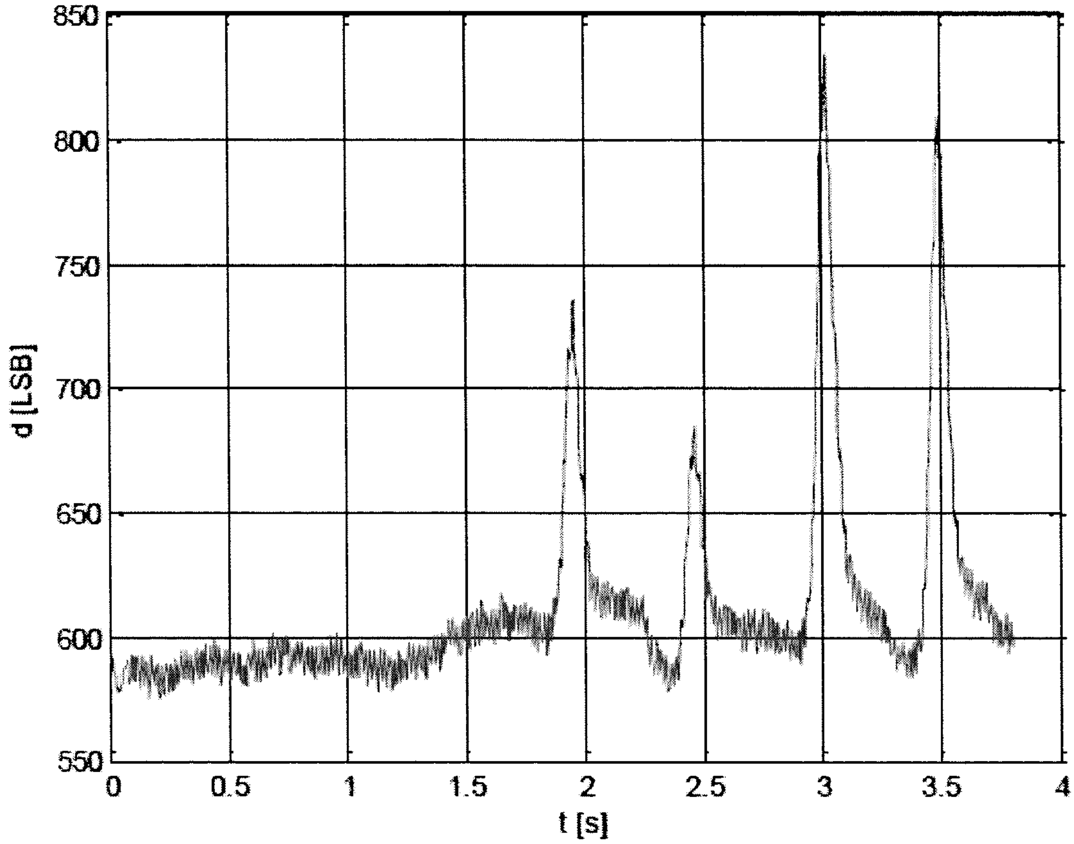


Figure 5

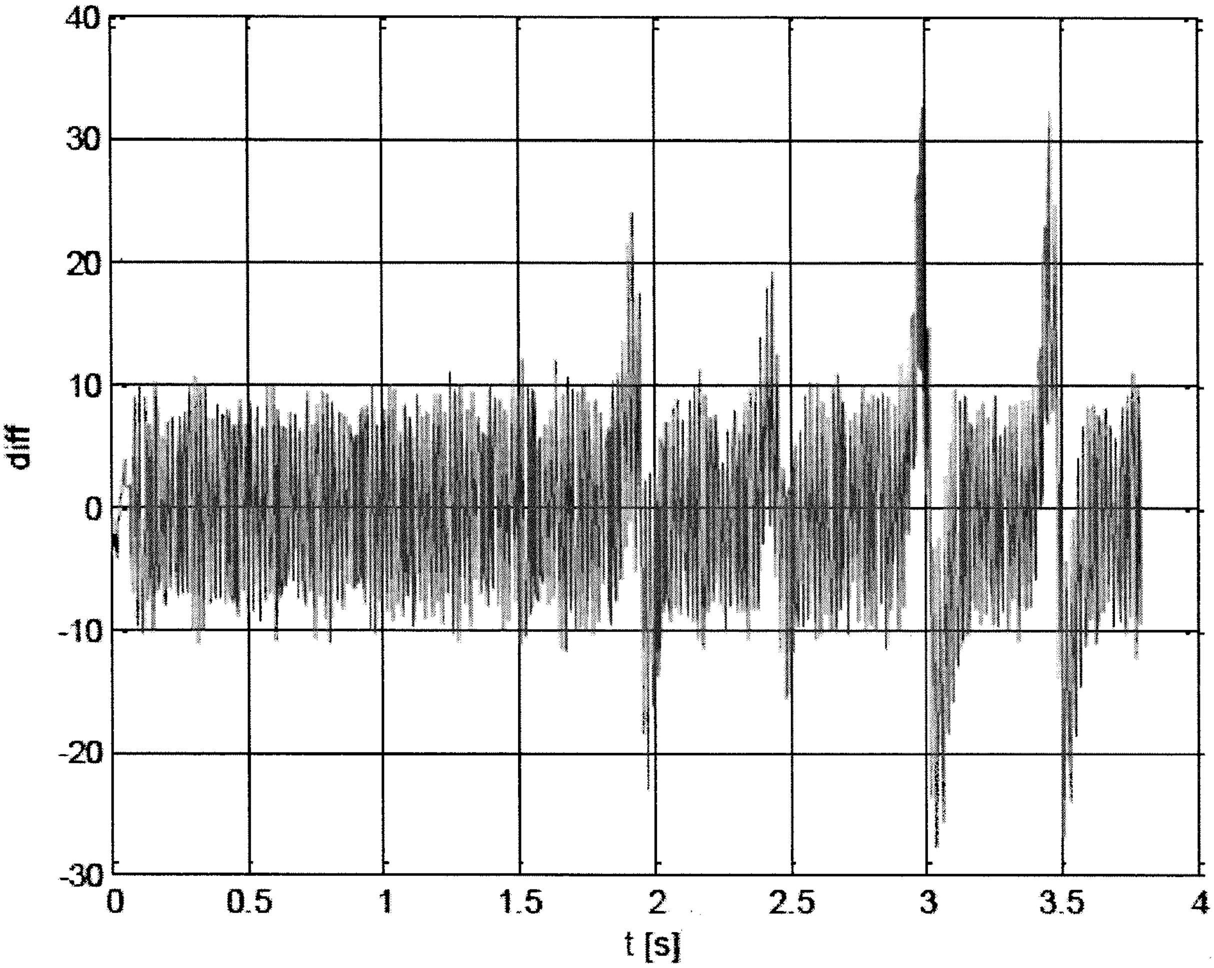


Figure 6

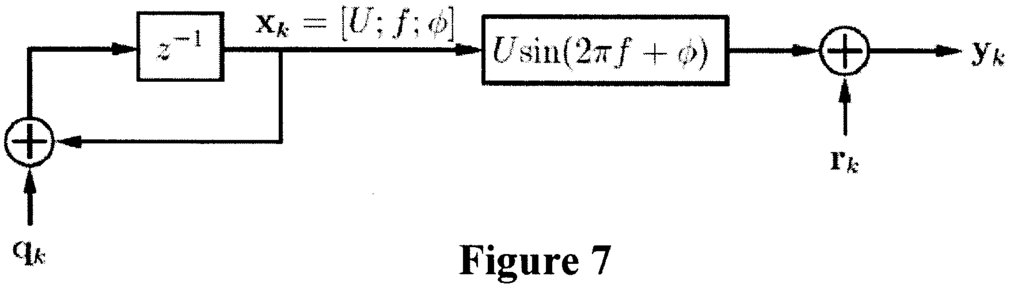


Figure 7

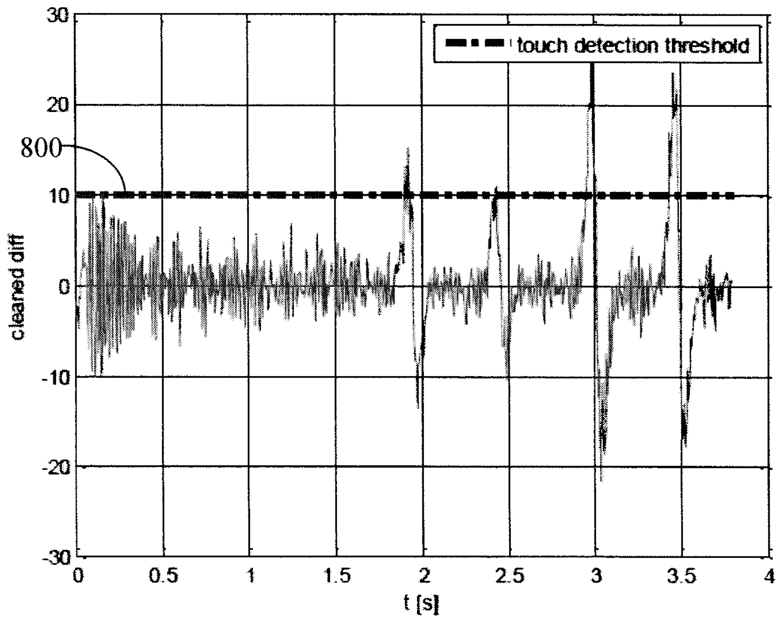


Figure 8

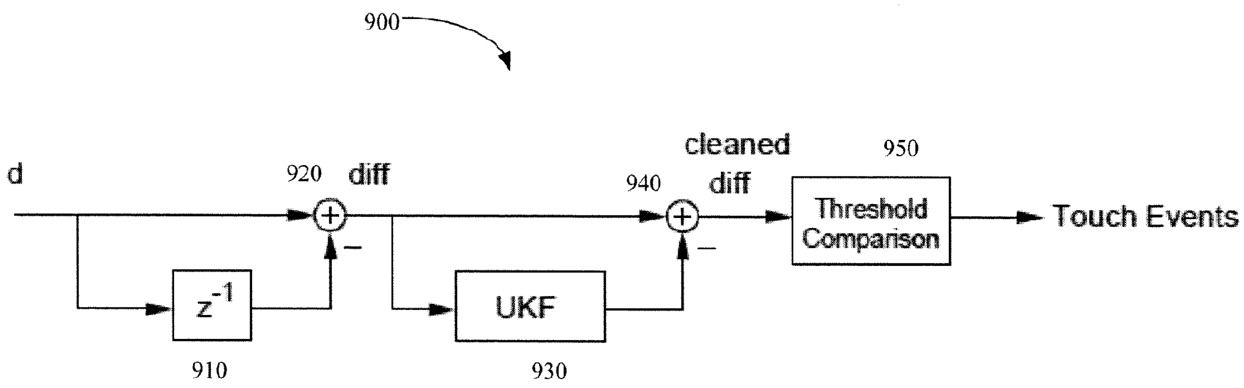

900
d
920
diff
cleaned
diff
940
950
Threshold
Comparison
Touch Events
z-1
910
UKF
930

Figure 9

REFERENCES CITED IN THE DESCRIPTION

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